The Use of Portable Fire Extinguishers in Nightclubs

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Background

A fire occurred on the night of Feb. 20, 2003, in The Station nightclub in West Warwick, Rhode Island, when the band, during its performance, used pyrotechnics that ignited polyurethane foam insulation lining a portion of the walls and ceiling. The fire spread quickly over the dance floor and smoke was visible in the exit doorways in a little more than one minute. Egress from the nightclub, which was not equipped with sprinklers, was hampered by crowding at the main entrance to the building. One hundred people lost their lives in the fire.

The National Institute of Standards and Technology (NIST) conducted an investigation to determine the likely technical causes of the building failure that led to the high number of casualties. The investigation concluded that strict adherence to 2003 model codes available at the time of the fire would go a long way to preventing similar tragedies in the future.[1]

Ten recommendations to improve model building and fire codes, standards and practices (as they existed in February 2003) resulted from the investigation: (1) urging state and local jurisdictions to (a) adopt and update building and fire codes covering nightclubs based on one of the model codes and (b) enforce those codes aggressively; (2) strengthening the requirements for the installation of NFPA 13[2] compliant automatic fire sprinklers; (3) increasing the factor of safety on the time for occupants to evacuate; (4) tightening the restriction on the use of materials that ignite as easily and propagate flames as rapidly as non-fire retarded foam as an interior finish product; (5) further limiting the use of pyrotechnics; (6) urging state and local authorities to adopt and adhere to existing model standards on communications, mutual aid, command structure and staffing; (7) conducting research to understand better human behavior in emergency situations; (8) conducting research to understand fire spread and suppression better; (9) conducting research to refine computer-aided decision tools for resource allocation, and (10) performing a study to determine the minimum number and appropriate placement (based upon the time required for access and application in a fully occupied building) of portable fire extinguishers for use in new and existing nightclubs, and the level of staff training required to ensure their proper use.[3]

In furtherance of this last recommendation, NIST organized a workshop for interested parties to identify (1) the relevant issues that should be addressed in such a study, (2) those organizations interested in partnering with NIST to conduct the study, and (3) those organizations interested in

[1] The complete report and other information regarding the NIST investigation are available on line at http://www.nist.gov/public_affairs/ncst.htm#Rhode_Island_Nightclub

[2] *NFPA 13 -- Standard for the Installation of Sprinkler Systems*, 2002 edition, National Fire Protections Association, Quincy, MA.

[3] Grosshandler, W., Bryner, N., Madrzykowski, D., and Kuntz, K., Report of the Technical Investigation of The Station Nightclub Fire, NIST NCSTAR-2, National Institute of Standards and Technology, Gaithersburg, MD, June 2005.

providing resources (equipment, in-kind, or other) for testing or analysis to fill in possible gaps in knowledge. The workshop was held at NIST in Gaithersburg, Maryland, on January 17, 2007, and was attended by one or more representatives from the fire protection equipment industry, codes and standards developing organizations, building owners and managers, fire testing and equipment certifying laboratories, the fire services, and the federal government. A complete list of attendees is appended to this report.

Objective and Format

The objective of the one day workshop was to develop a partnership among stakeholders to support, guide, and participate in a study as recommended in The Station nightclub fire investigation report of 2005;[3] i.e., to determine the minimum number and appropriate placement (based upon time required for access and application in a fully occupied building) of portable fire extinguishers for use in new and existing nightclubs, and the level of staff training required to ensure their proper use.

The workshop consisted of background talks and general discussion. Following a tour of the NIST facilities, presentations were made by William Grosshandler of NIST on The Station nightclub fire -- the impetus for the workshop; by Mark Conroy of the National Fire Protection Association (NFPA) on recent revisions to NFPA 10;[4] by George Laverick of Underwriters Laboratories (UL) on test methods and the experience of UL; by Craig Voelkert of the Fire Equipment Manufacturer's Association (FEMA) on the perspective of the fire protection equipment manufactures; and by Matt Chibbaro of the Occupational Safety and Health Administration (OSHA) on the use of fire extinguishers for occupational health and safety. Copies of the presentations are included in Appendix B of this report.

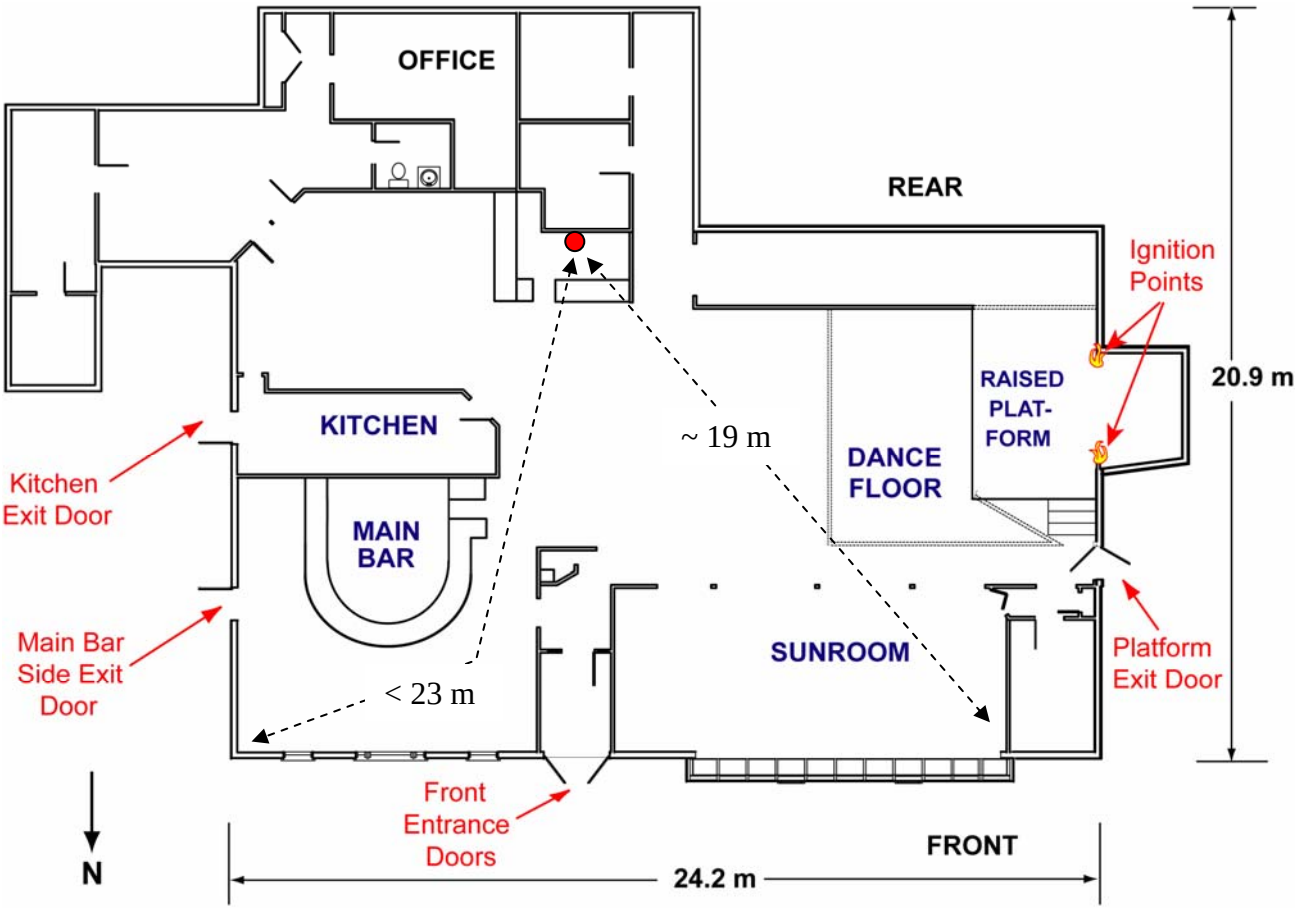
Current Requirements in NFPA 10 Applicable to Nightclubs and Places of Assembly

Places of business in buildings similar to The Station nightclub would be classified as a Group A-2 occupancy according to the International Building Code (IBC), and as Assembly according to NFPA 5000. The Station was a one story wood frame construction, with the main floor covering 4484 ft^2 (416 m^2). The dance floor and sunroom area together was about 48 ft by 36 ft (14.4 m by 10.9 m). Maximum occupant load for this building was limited by egress capacity (and not area) to 420 people, according to both the IBC and NFPA 5000.

Performances took place on a platform at one end of the dance floor. (The arrangement in The Station did not fit the definition of a stage, and, hence, did not have to meet the more stringent fire code associated with a stage.) As seen in the floor plan on the next page, the longest path of travel with the tables and chairs removed from the dance area and around the platform (i.e., festival seating) to the back bar where a fire extinguisher (red dot in figure) was mounted on the wall was about 61 ft (19 m). The maximum walking path from one corner of the main bar room (as distinct from the back bar) to the same fire extinguisher was less than 75 ft (23 m).

All assembly occupancies are required to have portable extinguishers, as specified in the , Uniform Fire Code,[5] Table 13.6.1.2. The type, size and number of fire extinguishers depends upon the primary fuel source, the hazard classification of the space, and the coverage area:

[4] *NFPA 10 -- Standard for Portable Fire Extinguishers*, 2007 edition, National Fire Protections Assoc., Quincy, MA.
[5] *NFPA 1 -- Uniform Fire Code*, 2006 edition, National Fire Protections Association, Quincy, MA.



Floor plan of The Station nightclub

- Fuel-type: Areas in the building that contain predominately solid fuels (e.g., wood finishing materials, furniture and office equipment) are appropriately protected with a "Class A-type" fire extinguisher; areas with substantial amounts of liquid fuels require a "Class B-type" fire extinguisher.
- Hazard Classification: Assembly areas, as well as offices and hotel rooms, are normally classified as "Light Hazard." When between 1 gal (3.8 L) and 5 gal (19 L) of a flammable liquid is in an area, NFPA 10 classifies the room as an "Ordinary Hazard," and more than 5 gal (19 L) of flammable liquid increases the occupancy classification of that space to "Extra Hazard."[4]
- Coverage Area: The UL classification of the fire extinguisher is related to the size of the area it can protect. The performance of a 1-1/2 gal (6 L) capacity pressurized water-type fire extinguisher is classified as 1-A, and provides a baseline against which other extinguishers are rated. A fire extinguisher rated as 2-A can cover about twice the area as a fire extinguisher classified as 1-A. The maximum floor area coverage for a single 2-A

extinguisher is 6000 ft^2 (557 m^2) and the maximum travel distance from the location of the fire extinguisher to anywhere in the space to be protected is 75 ft (23 m).

Table 6.2.1.1 of NFPA 10 states that a single fire extinguisher in The Station nightclub with a minimum rating of 2-A would have met the Standard.[4]

If an authority having jurisdiction (AHJ) does not consider distilled spirits behind a bar as incidental, a class B portable extinguisher would be required in that area. Ordinary Hazard classification requires a 10-B rated fire extinguishers located every 30 ft (9 m) or a 20-B extinguishers placed at 50 ft (15 m) intervals. (Refer to NFPA 10 Table 6.3.1.1.) An Extra Hazard classification boosts the rating on the portable fire extinguishers by a factor of four.[4]

A kitchen in a nightclub would have additional requirements, including a fixed kitchen hood suppression system and a class K rated portable.[4, 6]

Issues Identified

A number of questions evolved during the general discussion among the workshop participants that can be paraphrased as follows:

- Do reliable data exist that establish (1) the effectiveness of portable fire extinguishers in protecting property and reducing injury; or, conversely, (2) the possible negative impact of having a portable fire extinguisher available to an untrained public? If not, what methods and metrics are needed to gather these data?
- What level of portable fire extinguisher training is necessary and reasonable to expect for designated staff in nightclubs and other places of assembly, considering the lack of experienced staff and the high turnover rate typical of these places of business?
- How large of a fire should one expect to be handled by a portable fire extinguisher; and have changes in modern finish materials, furnishings, and building contents led to changes in the way that portable fire extinguishers can be or should be rated and used?
- Is 75 ft (23 m) the right distance to space the placement of A-rated portable fire extinguishers, or is the minimum time to reach a portable extinguisher more appropriate to specify than the minimum distance?
- What role can new technologies play in improving the effectiveness of portable extinguishers and/or reducing the cost of inspection, maintenance, monitoring, enforcement and notification, and what unintended consequences might result from their implementation?

No attempt was made to gain consensus on the answers to these questions at the workshop; the material that follows is the result of a review of the summary as assembled by the report editor.

Do reliable data exist? The data that exist relating to the use of extinguishers by the general public is incomplete, but some attempts have been made to evaluate the use and effectiveness of portable fire extinguishers. For example, the Consumer Product Safety Commission (CPSC) stated in 1984 that 90 % of home fires go unreported to fire departments. It can be assumed that a large number of non-residential fires are also unreported. Based upon data collected prior to the use of the latest version of the National Fire Incident Reporting System (NFIRS 5.0), which

[6] *NFPA 96 -- Standard for Ventilation Control and Fire Protection of Commercial Cooking Operations*, 2004 edition, National Fire Protections Association, Quincy, MA.

show that a significant number of fires were extinguished with portable fire extinguishers, it is not unreasonable to assume that an equivalent fraction of non-residential fires were extinguished by portable fire extinguishers without incident.

According to national data collected and analyzed from 1990 to 1994 from the NFPA, almost 36 % of fires in public assembly structures were extinguished in the incipient stage by either fire extinguishers or makeshift means. These data show that without fire extinguishers, occupants commonly used other tools to try to extinguish fires. (Note that the method of extinguishment was dropped from NFIRS as a reporting requirement in 1996.)

People often fight a fire whether or not a fire extinguisher is available. Data from 1990 to 1994 show that every year, occupants using makeshift means extinguished about 8 % of fires in public assembly structures. Portable fire extinguishers, in contrast, were used to extinguish about 28 % of the fires, which is what extinguishers are designed to do (as well as to keep flames at bay to allow occupants more time to exit a structure).

While portable extinguishers provide a first line of defense for occupants until the fire department arrives, the fire service continues to have some concern (though no hard data) that using a portable fire extinguisher can delay the notification of the fire department.

What level of portable fire extinguisher training is necessary? The level of portable fire extinguisher experience and training necessary for an employee being able to effectively use an extinguisher on incipient fires is not necessarily all that complicated or costly. There are numerous programs available for training staff in the proper use of portable fire extinguishers. These are offered by NFPA, UL, through the Fire Equipment Manufacturer's Association (FEMA) and by consultants. For example, see publicly available materials at www.fireextinguisher.com, an online educational program that includes an interactive training program covering the use of fire extinguishers. There are separate training programs for each type of fire extinguisher in use today (water/foam, carbon dioxide, dry and wet chemical, clean agent and water mist).

How large of a fire? The test procedures specified in UL 711[7] to establish the fire extinguisher ratings in NFPA 10 include fully involved fires in wood cribs, oil-soaked wood vertical panels, and liquid heptane pans. Dry chemical hand-held type ABC fire extinguishers are available in sizes up to 20-A and 120-B. To receive a 2-A rating, the extinguisher must successfully tackle a fully involved fire in a 19 in x 26 in x 26 in (0.49 m x 0.65 m x 0.65 m) wood crib and in a 10 ft x 10 ft (3 m wide x 3 m) high oil-soaked wood panel. To achieve a 10-B rating, a hand-held extinguisher must be able to control a 31 gal (117 L) heptane pan fire covering an area of 25 ft^2 (2.3 m^2). The UL tests are conducted by expert technicians, so a safety factor of about 2.5 is applied to reduce the rated coverage area to allow for the inefficiencies inherent with an inexperienced user. For example, if an expert can put out a 25 ft^2 (2.3 m^2) fire, it is assumed that a novice can handle up to a 10 ft^2 (0.92 m^2) fire with a 10-B rated extinguisher.

These test fires are relatively large but are not growing, which means delaying the attack for ten or twenty seconds is unlikely to seriously degrade the performance of the fire extinguisher.

[7] *Standard for Safety UL 711 -- Fire Extinguishers, Rating and Fire Testing*, Underwriters Laboratories Inc., Northbrook, IL, 1995.

Modern furnishings and building finishing materials often contain a high percentage of plastics which have been shown to spread fire and release heat at a rate much faster than older designs that incorporate mostly natural fibers, leather, and wood.[8] It is unknown how these newer materials might affect the fraction of times that a portable extinguisher successfully controls the fire.

Is 75 ft (23 m) the right spacing? At a brisk pace, an average person can walk an unobstructed 75 ft (23 m) path in ten to fifteen seconds. If the individual and the fire are both located the maximum distance from the fire extinguisher, twenty or thirty seconds could have passed between the time when the decision was made to attack the fire and the individual was in the right position armed with the fire extinguisher. For the standard fires used in UL 711, this would pose no problem; for faster growing fires that can occur in foam furniture, a thirty second delay may lead to a situation that is beyond the capability of the portable extinguisher.

The time calculated above to travel 75 ft (23 m) assumes the path is unobstructed, which is reasonable when a nightclub is only lightly occupied. However, when the assembly area is set up for festival seating and patrons are tightly packed around the performers (even when the maximum occupancy limit is adhered to), the time to travel 75 ft (23 m) is greatly increased. A rough estimate of the travel speed can be made by tracking the time it took the WPRI-TV cameraman to move away from the dance floor during The Station fire: roughly 1.6 ft/s (0.5 m/s). This translates to about 46 s to travel 75 ft (23 m). If one multiplies this time by two, for a fast growing fire a minute and a half delay could render a 2-A portable extinguisher ineffective.

What role can new technology play? The technology to electronically monitor a facility's fire extinguisher inventory had not been introduced to market when the fire occurred in West Warwick, Rhode Island. Today there is UL listed technology designed to automate monthly extinguisher inspections (which is different from the NFPA 10 requirement for annual extinguisher maintenance[4]) to ensure that fire extinguishers are pressurized, properly located and always accessible. The most recent NAFED (National Association of Fire Equipment Distributors) study shows that over 90 % of fire extinguishers are not being inspected every 30 days, as required by code. Depending on the type of monitoring panel, it is possible to maintain an electronic log showing when the extinguishers had been removed from their designated location for annual maintenance.

A concern that has been raised with electronic monitoring is that the staff no longer have as much incentive to locate and heft the portable extinguishers on a routine basis, and, therefore, would be less familiar with the hardware, less likely to notice obvious maintenance issues (such as a missing hose), and less likely to locate and operate the fire extinguisher in an emergency.

The capability exists today to have the removal of a fire extinguisher from its stand automatically trigger the local fire alarm. This would alert others in the vicinity to the danger and could even activate a recorded message instructing the patrons to call the fire department.

[8] See, for example, Bukowski, R. W., Peacock, R. D., Averill, J. D., Cleary, T. G., Bryner, N. P., Walton, W. D., Reneke, P. A., and Kuligowski, E. D. "Performance of Home Smoke Alarms, Analysis of the Response of Several Available Technologies in Residential Fire Settings," Natl. Inst. Stand. Technol., Tech. Note 1455 (2004)

Proposed Actions

For the NFPA and the International Code Council (ICC)

The model code organizations should consider defining nightclubs as a specific category and deal with all the public safety issues associated with that type of operation. For a nightclub in which live performances are held, for example, the code might require that portable fire extinguishers be conveniently located on both sides of the performing area (whether the performance is on a dance floor, platform, or stage). The maximum spacing between fire extinguishers should reflect the reality of a non-uniformly distributed crowd, and account for the actual time that it might take to cross through or go around the crowd.

The need for fire extinguisher locations to be visible and readily identifiable within public places should also be emphasized. The excitement associated with a fire and the added factor of potential crowds within unfamiliar public occupancies can reduce the possibility of using the extinguisher. While not everyone present in a public building might be willing to use an extinguisher in an emergency, not having them readily available removes any possibility that small fires can be addressed before they get out of hand.

Some attention should be given to the possibility that a considerable amount of a flammable fluid (e.g., a case of 100 proof vodka) could be accidentally dropped anywhere in the nightclub and ignited by a candle or cigarette. Would a 2-A portable extinguisher be up to the job of controlling that situation? Is there a need for a 10-B rated extinguisher in this case?

For NIST and UL

NIST, working with UL, should conduct a study to determine if a possible change in the formula to install fire extinguishers would make a positive impact. The study should be designed to determine how well UL 711 represents the fire environment that a portable extinguisher might encounter in a nightclub. Parameters that could be examined include the geometry and make-up of the fuel packages, the rate of growth of the fire, and the heat release rate from the fire when the extinguisher is first activated.

Leaving aside the possibilities of arson and gross model code deviations, this study should identify fire scenarios that would be the most challenging to a portable fire extinguisher. For example, using only materials that are code compliant and common in nightclubs (e.g., distilled spirits and upholstered furniture) and accidental behaviors that are known to occur (e.g., dropped bottles and tipped over candles), one could compose a scenario that would lead to a sudden ignition over a relatively large area, in close contact with a large fuel supply, that could lead to a fire that would grow rapidly and produce a substantial amount of heat and products of combustion if not extinguished promptly. Tests against this fire scenario with different models and ratings of extinguishers could be conducted to determine if they are effective after increasingly longer delay times between ignition and activation. Based upon these results, it would be possible to translate the maximum delay time for a successful suppression to a maximum distance of portable extinguisher spacing (assuming a fully-occupied building). Tests could also be conducted to compare the performance of class A-, B- and ABC-rated portables on the same fire.

The results of these tests would be provided to the NFPA 10 committee to guide future deliberations

For Industry

Industry can play a leadership role in educating the staffs of public assembly occupancies on how to use fire extinguishers by taking advantage of the required maintenance of fire extinguishers to conduct brief training programs during those times. Fire extinguishers in public assembly occupancies need to be maintained by either fire extinguisher service agencies or by trained industrial safety personnel. When maintenance occurs the trained personnel or the service agencies could work with the managers of the occupancy to assemble staff and take an additional 30 minutes to review how a fire extinguisher operates. If the additional 30 minutes is a liability to the service agency then they could charge for the 1/2 hour demonstration.

Development and promotion of inexpensive innovations aimed at low-end extinguishers and systems (which are most likely to be installed in small nightclubs), such as triggering the fire alarm when a portable extinguisher is removed from its holder, should be encouraged.

New NFPA10 recommendations call for fire extinguisher service personnel to be properly trained and certified. The industry should ensure that this service can be provided at a fee that encourages widespread adherence to the recommendation.

For the Fire Service

The fire service needs to remain engaged in the codes and standards process, and to work with the industry in their efforts to improve portable fire extinguisher training for nightclub staff, including the importance of staff not waiting until after attempting to control the fire before contacting the fire department. Finding sufficient resources for rigorous inspections and other fire prevention activities needs to be assigned a high priority.

End-users

The end-users also need to remain engaged in the codes and standards process. Portable fire extinguishers play a role in fire protection in nightclubs; however, no matter how many extinguishers are present and no matter how well the staff are trained, there is no substitute for ensuring sufficient egress capacity and installing an NFPA 13 compliant sprinkler system.